# An Early-Warning Method on e-Learning

Jinlong Liu[1(✉)], Zhutian Yang[1], Xiangyuhan Wang[2], Xingrui Zhang[1], and Jianying Feng[1]

[1] School of Electronics and Information Engineering, Harbin Institute of Technology, Harbin 150006, China
{yq20, yangzhutian, zhangxr, fengjy}@hit.edu.cn
[2] Harbin No.3 High School, No. 17, Hashuang North Road, Harbin 150001, China
wangxyh@yeah.net

**Abstract.** Early-warning is an important way which can promote teaching effect on e-learning. However design a better system of early-warning based on big data is an open issue. This paper systematically analyses five key factors which act on e-learning, compare the effect on early-warning, summarize the insufficient of existing systems. Besides one kind of system framework on e-learning proposed, the system establishes functional model and procedural model for early-warning system. Research results show that the system can promote teaching effect for e-learning and can benefit the development of early-warning model.

**Keywords:** Big data · Early-warning · e-Learning · Prediction modeling
Promote teaching effect

## 1 Introduction

With the application and development of Internet Technology, e-learning has become increasingly popular and drawn wide attention from governments, schools and enterprises. It has become an important learning method in the information age. At present, the development of e-learning is increasing rapidly, but there are also many problems, such as low learning quality and efficiency, poor ability of teachers in adaptive teaching, inadequate supervision and untimely feedback system [1–4]. Among them, the most important problem is that it is difficult to guarantee the quality of learning, resulting in many learners cannot successfully complete the online course learning. Therefore some researchers have proposed early-warning to solve the above problems [5–9, 13].

Early-warning system can acquire and analyze the massive data generated in the process of e-learning. And then it will understand the learners' learning situation and discover problems in learning in time [10, 11]. By issuing reminders or warnings to learners, early-warning prompts and guides learners to complete online course successfully. The research and practice of online early-warning are overall in their infancy both at home and abroad. For example, the curriculum warning system developed by the Purdue University in the United States, social network visualization tools developed by Wollongong University in Australia. In China, Institute of educational data of


S. Liu et al. (Eds.): eLEOT 2018, LNICST 243, pp. 62–72, 2018.
https://doi.org/10.1007/978-3-319-93719-9_9

the University of Electronic Science and technology has also developed a forecasting and warning system for colleges and universities. Compared with the traditional education data, the collection of education big data is more real-time, comprehensive and natural. The analysis and processing are also more complicated and diversified, and the applications are more diversified and in-depth [3, 12]. Based on big data, it is an important issue to figure out how to implement early-warning in the process of online education successfully. In this paper, based on the analysis of five typical early-warning system cases, a general framework is proposed for learning warning system, and functional model and process model are designed. It can help researchers to understand the framework and process principle of e-learning early-warning system better.

## 2 Typical Models of Early-Warning System in e-Leaning

The United States is the leader in big data. Some schools and agencies in the United States have taken the lead in developing different e-learning early-warning systems according to their own needs. These early-warning systems have made some achievements in related applications, especially in preventing dropout, and have accumulated valuable experience.

**Table 1.** Realization and algorithm in the typical models

| System | Realization form in e-learning | Technology, algorithm and instrument |
|---|---|---|
| Curriculum signal system | Standalone early-warning system which institute develops | Predicting success algorithm, Data mining, Analysis tool |
| Student success system | Standalone early-warning system which enterprise develops | Semantics decomposition, Prediction modeling, Learning analysis, Data visualization |
| Learning instrument panel in Khan Academy | Introduce visual tool in learning management system | Information tracing, Mirroring technology, Learning analysis |
| E-consultant | Introduce personalized tool | eAdvisor™ demand, Learning analysis |
| Starfish Early-warning system | Modularization Design | Big data, Distributed computation system, Self-rectification mechanism |

According to the form of early-warning function, the existing early-warning system can be divided into four categories: (1) Independent development of online early-warning which can be divided into two classes: One is self-developed by the school, such as Curriculum Signals developed by Purdue University; other one is developed by business organizations, such as Student Success System developed by Desire2Learn institutions. (2) Combined learning management system and visualization tools to achieve early-warning functions, such as learning dashboard in Khan Academy. (3) Embedding personalized tools in the learning system to achieve early-warning function, such as eAdvisor™. (4) As a module exists in learning early-warning system

of e-learning platform, such as Starfish Early Alert System. The five typical learning early-warning systems have differences in the form of realization, content and way of early-warning. There are also merits and drawbacks as shown in Tables 1, 2, 3.

### 2.1 Curriculum Signals System

Curriculum Signals System is an online early-warning system developed by Purdue University to monitor the learning status of students. The system attempts to use Student Success Algorithm (SSA) a new algorithm to identify the students who are in academic crisis. It gives a warning, which is similar to the traffic lights. The "warning signal" is set in different color when different state for the teachers and the students. According to the "warning signal", the teachers intervene and guide learners through e-mail, short message, online messages and other means, so that the learners can complete studies.

**Table 2.** Method and content in the typical models

| System | Warning method | Warning content |
|---|---|---|
| Curriculum signal system | E-mail, short message, system messages | Course grade, effort level, dropout |
| Student success system | Visual figure, E-mail develops | Academic alert, dropout |
| Learning instrument panel in Khan Academy | Instrument panel, E-mail | Knowledge point |
| E-consultant | E-mail | Learning path |
| Starfish Early-warning system | Small red flag, E-mail, short message | Course grade, effort level |

### 2.2 Student Success System

The Student Success System (S3), developed by Desire2Learn in the United States. The system provide a range of services, such as viewing student learning situation, predicting academic risk, providing interventions and generating learning analytics reports. In addition, the system can also form a variety of prediction models by analyzing factors that affect students' learning, including in student attendance, course completion, participation and social learning. Through the system the model is able to predict which students are in a state of academic danger accurately, and provides them with appropriate interventions.

### 2.3 Learning Instrument Panel in Khan Academy

The Learning instrument panel is launched by Khan Academy in September 2013 and is originally applied to Khan Academy's math course. Based on information tracking technology and mirroring technology, Learning instrument panel is able to track, record and integrate a large number of learners learning information. At the same time, it analyzes the data according to the needs of the users. Finally,a visual form such as figures and charts is provided to learners, teachers, researchers and education administrators in e-learning.

### 2.4 eAdvisor™

eAdvisor™ is developed by Arizona State University. By playing the image game Me3, learners' professional interests can be explored and eAdvisor™ can develop a learning path accordingly. It sets out the courses to be completed each semester and the credits to be obtained. Throughout the learning process, eAdvisor™ provides learners with personalized on-demand tools, as well as providing guidance and support for the learning process, including early-warning.

### 2.5 Starfish Early-Warning System

The Starfish Early-Warning System is a module in the Starfish Enterprise Success Platform, dedicated to helping students to complete their studies. Based on big data, learning analysis, distributed computing and so on, Starfish early-warning system tries to understand students by analyzing the engagement of learners, thereby to reduce the dropout rate.

## 3 Learning Early-Warning System Framework

Learning early-warning system involves four key points, namely, the reason for early-warning (purpose layer), warning for what (content layer), how to warning (way layer) and the results of warning (result layer). Starting from these four points, this research constructs a general framework of early-warning system, as shown in Fig. 1.

**Table 3.** Effect and insufficient in the typical models

| System | Effect | Insufficient |
|---|---|---|
| Curriculum signal system | Reduce dropout rate, grade improvement, administrative timesaver, administrative cost saving | Insufficient individuation, overmuch same intervention, not provided diagnostic message, not provided effective remedy |
| Student success system | Predict academic alert, offer suitable intervention, simplify administration | Low universality, non-technical person cannot execute predicted results |
| Learning instrument panel in Khan Academy | Improve mastery knowledge degree, improve self-skill, recommend personalized learning content | Apply to limited subjects, only mathematics curriculum, univocal early-warning content |
| E-consultant | Recommend professional curriculum, formulate learning path, arrange curriculum plan, assist graduation on time | Incomplete early-warning content |
| Starfish Early-warning system | Early understand student reduce dropout rate | Course grade effort level |

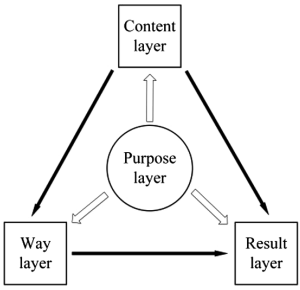


**Fig. 1.** Warning system general framework

### 3.1 Purpose Layer

There are four warning purposes: reduce the dropout rate, increase employment rate, promote academic success, and enhance the efficiency of learning. Confirm warning purpose determines the direction of the establishment and operation of warning system. It will directly affects the collection and acquisition of data, and influences the content layer, way layer and result layer, which is the basis of the warning process. The purpose layer is shown in Fig. 2.

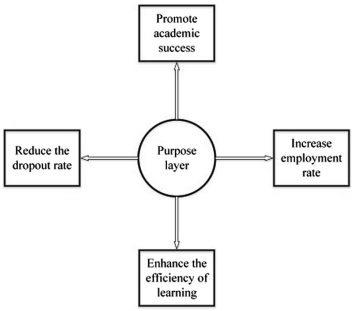


**Fig. 2.** Purpose layer

### 3.2 Content Layer

The warning contents include warning drop out, academic success, knowledge mastery, employment situation, learning path, learning effect and so on. The specific content will vary according to the purpose of warning. When the warning content is different, the warning way will be different, as shown in Fig. 3.

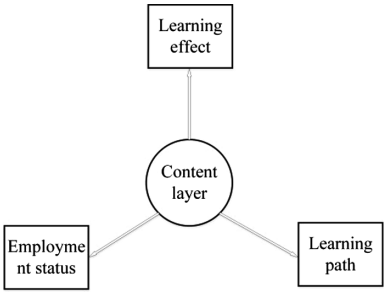


**Fig. 3.** Content layer

### 3.3 Way Layer

The warning way mainly contains data acquisition and data analysis. Data acquisition clarifies that which acquisition technology needs to be used and what data to be collected for data acquisition. Data analysis is based on the collected data; it decides which data analysis technology and warning algorithm to adopt. In the era of big data, the omnidirectional data of learners are collected, and different data will be selected for analysis and process when the purpose is different, as shown in Fig. 4.

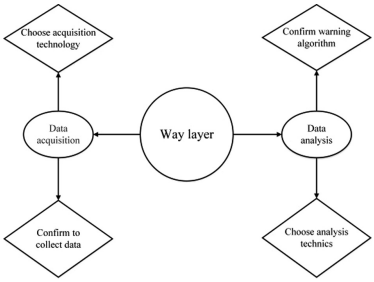


**Fig. 4.** Way layer

### 3.4 Result Layer

According to the purpose layer, content layer and way layer, the warning results provide the presentation way of warning information and intervention strategies. The presentation way of warning information is the intuitive manifestation of the learning warning system, and the intervention strategies are mainly to supply personalized advice or feedback for the learners, as shown in Fig. 5.

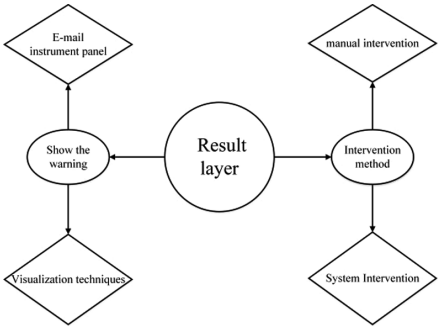


**Fig. 5.** Result layer

## 4 Learning Warning System Model

The Fig. 6 gives the function model of learning warning. It presents the workflow of the learning warning system. Specifically, there are four stages to realize the learning warning function: data collection, data analysis, warning information presentation and provide intervention. According the knowledge mastery of learners, behavioral data and academic emotion, this research constructs the e-learning warning function model refer to the technical framework of big education data, and warning from the full range of learners, including knowledge, practice and emotion in e-learning.

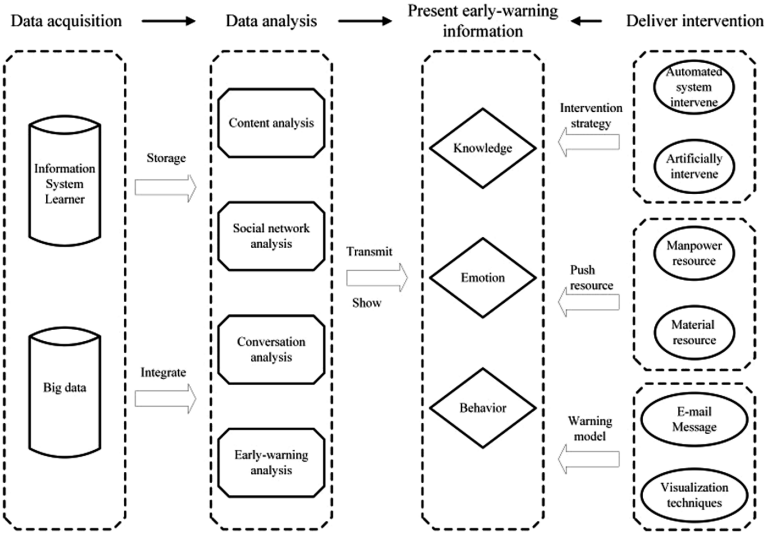


**Fig. 6.** Learning warning function model

### 4.1 Data Collection

The collected data in e-learning system includes the related data of learners, teachers and courses. Among them, the specific data of learners are as follows: essential data (learning style, attitude), behavior data (visit count, online time, download time, last access time), interactive data (interaction with online resources or classmates, interactions number, discussion content, and posts), performance data (academic achievement, ranking, and progress), emotional data and so on. Data collection needs acertain platform or technical tool, such as Sakai, Blackboard, Moodle, Learning Meta Platform and social network visualization tool.

### 4.2 Data Analysis

The massive collected data can be classified after storage integration, which can be divided into knowledge, behavior, and emotion. At present, the knowledge and behavior analysis technologies are more mature, such as content analysis, discourse analysis, social network analysis, context analysis and personality analysis. The recognition of facial expression and speech emotion both are emotion recognition technology. In addition, it also can identify the emotional information of voice, text, drawing from learner through content mining and intelligent analysis. The technology of emotion recognition and acquisition based on brain waves has become an important channel of emotional data acquisition and emotion recognition. The above technologies promote the data analysis carried out smoothly, to predict whether there is an abnormality in the knowledge, behavior and emotion of the learners.

### 4.3 Warning Information Presentation

The warning information presentation includes knowledge, behavior and emotion; it is a visual representation on status of learners. Knowledge is the mastery of the knowledge point by the learners. In order to adapt to the development of society, we must continue to accept new knowledge and continuously improve the quality and ability. Moreover, it can judge the mastery situation of the knowledge by achievement and content analysis. The behavior of the learner includes login, browsing, and interaction on e-learning. To a certain extent, the behavior of learner maps the attitude and the learning effect. Emotion is the mood of the learner on e-learning, is an important variable that affects the learning effect online and offline. Warning information presentation correctly identifies the learning situation and status of learners through analyzing massive data, and shows them intuitively through red and green lights, red flag, magnetic stripe, background color and text.

### 4.4 Provide Intervention

Provide intervention refers to afford corresponding improvement strategies and positive intervention for warning learners. The warning system involves a perfect library of learning intervention strategies, which contains specific strategies to deal with all kinds of problems. Teachers or systems can provide personalized intervention to learners

accordingly. Personalization means that when the learners with different starting points achieve the same results, the interventions obtained are different. Moreover, when the learners and warning contents are different, the intervention methods will also be different.

## 5 Learning Early-Warning Process

Learning early-warning process is shown in Fig. 7, it mainly describes the specific steps during the early-warning system,In general, there are seven steps in the learning early-warning process for e-learning:

1. Confirm the early-warning purpose and the early-warning content. On the basis of the early-warning purpose, detailed steps are formulated to e-learning.
2. Data acquisition. Depend on the early-warning purpose, choose the appropriate data acquisition technology, and confirm that which data needs to be acquired.
3. Data analysis. Transmit the acquired data to the analysis engine, choose the appropriate analysis technics and the specific early-warning algorithm to analyze the acquired data, appraise whether or not the learner needs the early-warning.
4. Present the early-warning information and the learning state. Based on the acquired data analysis of the third step, if the learner needs the early-warning, early-warning information is presented; if the learner doesn't need the early-warning, the learning status is shown.

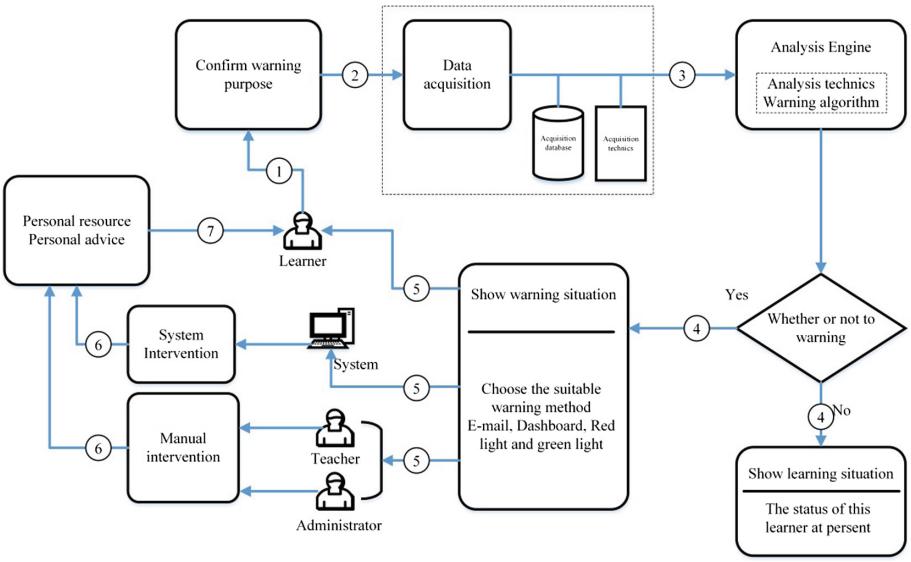


**Fig. 7.** Learning early-warning process

5. Transfer the early-warning information. There are three objects which the early-warning information is transferred to, include the teacher and the administrator (who can examine the whole early-warning information); the system (which stores the early-warning information in big database); the learner (who can acquire part of the early-warning information, because some of the early-warning information could hurt his self-respect).
6. Propose the personalized recommendation and recommend the personalized resource. Based on the transferred early-warning information, the teacher and the administrator execute the manual intervention, propose the suitable recommendation and the personalized recommendation, and recommend personalized resource for the learner. On the basis of the transferred early-warning information, the system combines the adaptive analysis engine, automatically generates the personalized recommendation and the personalized resource for the learner.
7. The personalized recommendation and the personalized resource are transferred to the corresponding learner.

## 6 Conclusion

This paper designs the early-warning mechanism, and develops the early-warning system prototype in e-learning. In this early-warning mechanism, the various elements which exist in the knowledge, the behavior and the emotion during the e-learning are designed in detail. It shows clearly what data needs to be acquired, what data needs to be analyzed, which algorithm needs to be chosen and which mode needs to be presented for the early-warning result in e-learning. Not only the knowledge that learner master can act on the learning effect, but also the behavior and the emotion of the learner can apply to the learning effect, so the early-warning is an integrated process in e-learning. Based on the knowledge, the behavior and the emotion, this paper proposes the early-warning model in e-learning, and designs the early-warning mechanism in e-learning. The research contents of this paper can guidance the designer to develop the early-warning system, and can promote the learning quality in the e-learning. The early-warning mechanism and the early-warning system prototype possess the practicability and the maneuverability.

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